

## STATUS OF THE JAWS PROGRAM

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The preliminary data description of the August 5, 1982, microburst case is available (ref. 1). We need to discuss its use. The turbulence part, however, is not yet out.

Let me tell you basically what our simulation accomplishments have been from our perspective at the National Center for Atmospheric Research (NCAR). We have prepared and distributed through this forum and on tape the August 5, 1982, microburst data set for a single time. It does not include turbulence. It is a one-time velocity and is currently available. We will shortly make available four such velocity fields, two minutes apart, for the same August 5 case, so that the dynamic change of the microburst can be simulated. There is more data than you may want on the August 5 microburst. However, from this case you can see the birth, evolution, and depth of the microburst. The turbulence data is also available for this case.

QUESTION:

There are some other data sets in industry and NASA. You are speaking only of one here. Are you saying that this is probably the best, the most representative one you have? What cautions should we use on some of the other ones?

RESPONSE:

There are two other data sets which have been looked at in a preliminary fashion. The first one was June 29, 1982, which should not, in our opinion, be used because it was the first one we analyzed. We question the accuracy of the data due to problems of resolution caused by the distance from the radar. In general, it is a good microburst, but it does not have the resolution or accuracy of the August 5 case. Another case that was looked at very briefly was the July 14, 1982, case. Another case that was looked at and it has not been released for any real use. The only case which we feel is top-notch at this point is the August 5, 1982 sequence. There are three other times we have looked at carefully, and they're about to be sent from NCAR through the processing loop to FWG Associates and to NASA for general distribution.

An in-depth analysis of the July 14, 1982, case, which is a moderate case, is basically unfunded. We consider August 5, 1982, to be a significant microburst. The June 30, 1982, case has not yet been distributed, although analyses of it have been done for research and fundamental characterization issues. It is a larger scale flow with a fairly intense mesocyclone in it. It is a very nice case for looking at what might happen if you get into a fairly large flow that has an intense cyclone.

For these cases, the objective is to develop 1-, 2-, and 3-plane slices through the more severe wind shear as sub-volume data set as well as to provide a full-volume data set. They will include three-dimensional time dependent velocities and radar reflectivity intensity when we have it, as well as turbulence data.

There are two major tasks that are currently not funded. The first one is a statistical characterization of all the cases we get a chance to analyze. We measured many microbursts in JAWS. We "saw" at least 75 on Doppler radar. Analyzing these is an intensive job, so there is a limit as to how many we can do. We want a full characterization: how big they are; how asymmetric they are; the maximum/minimum velocities; the vertical velocity structure, etc. One point that Kim did make (ref. 2), and about which misconceptions exist is that the maximum vertical velocity that we are getting at 250 m is about 2,000 fpm. There are values being quoted right now that are three to four times this value. The surface boundary conditions preclude larger vertical velocities than that near the ground. At 250 m, we are seeing about 2,000 fpm down, and this value decreases linearly to zero at the ground. Values different from that are not substantiated by the data. So, the final two tasks, if we can secure support for them, are a full statistical characterization of the cases which we have analyzed with multiple Doppler, and the establishment of a simplified analytical or numerical model of microbursts based on actual JAWS Doppler radar data.

We think that one of the things you are going to need, and which you do not currently have, is a simplified numerical or analytical curve fit of the data sets. The simplified model, in our opinion, does not actually characterize real data. We think we can develop a simple model from curve fit data, however. Figure 1 shows things that we have done or can do. We can look at velocity and turbulence intensity. We have several cases available and more could be made available. Additional support is going to be needed to complete this job.

#### QUESTION:

Do you have a feeling for both the average and the maximum of both the horizontal and the vertical shears as a function of altitude? You just mentioned one starting at 250 m at 2,000 fpm and decreasing linearly.

#### RESPONSE:

The maximum that we observed on Doppler and feel comfortable with is a horizontal change of 48 m/s (approximately 100 kts) over about 3 km. The peak of our sine wave or the sawtooth wave that you are using would be 48 m/s amplitude wave. I think that's the maximum that we've observed in JAWS. Now, we know that there is evidence of a stronger microburst. We think the one that hit Andrews Air Force Base was substantially stronger. Of the five cases that we have looked at, the vertical velocity decreases nearly linearly with height from zero at the surface to 2,000 fpm or 11 m/s at 250 m; at 500 m, it could possibly double. Above that altitude, the multiple Doppler analysis technique that we use falls apart, so that above roughly 1,000 m, we don't feel terribly comfortable with our vertical velocity. At the altitudes of approach and takeoff, we feel quite comfortable with it. But note that one of the tasks on Figure 1 is a full statistical characterization for the purpose of simulation, and that is a task we have not yet done. We don't want to do it until we have analyzed enough cases to develop that body of statistics.

#### QUESTION:

I think the thing that we need, from the standpoint of training, is a good feel for what some of the outside parameters are. What is the two or three standard deviation value; what are we looking at from the standpoint of downbursts; what are we looking at from the standpoint of horizontal shears? That would be very helpful to us; because, quite frankly, we don't know much to put in our simulator models which we have right now.

- NEW, REAL, 3- to 4-DIMENSIONAL DATA
- LIGHT, MODERATE, SEVERE MICROBURST CASES
- VELOCITY, TURBULENCE, INTENSITY
- SEVERAL CASES AVAILABLE
- MORE CASES COULD BE AVAILABLE
- MODEL SIMPLIFICATIONS COULD BE AVAILABLE
- STATISTICAL CHARACTERIZATION COULD BE AVAILABLE
- MORE GOVERNMENT/INDUSTRY SUPPORT (\$) NEEDED TO FINISH JOB

Figure 1. Conclusions.

RESPONSE:

One problem that we aren't going to solve is that we are underestimating the shears. The smoothing that occurs in this analysis underestimates the peak magnitude to some degree, probably 20%, so we know there is some underestimating going on.

QUESTION:

If you conduct an analysis using the continuity equation and consider a continuous flow, and then you limit the downward flow at 250 m, you come up with horizontal outflows that are not nearly on the order of what was estimated to have occurred at Andrews Air Force Base (see ref. 3). Considering that it is possibly a vortex ring, as hypothesized by several researchers, it has a significant effect on analysis. You could have the type of downward flow you are talking about and still generate these extreme horizontal flows very close to the surface. Will you comment on that, please?

RESPONSE:

Continuity still applies, but it only applies to the resolution of your data. If there are some very small-scale flows embedded in there that you cannot resolve, then certainly there could be flows from any source, such as vortex rings, that we aren't resolving. Fluid flow continuity is still valid.

QUESTION:

I agree with that; however, they are assuming a continuous downward flow without the vortex.

RESPONSE:

Assuming a continuous flow is not required. What you are really addressing is resolving a flow smaller than the radar resolution. It is certainly possible that those flows are there and that we cannot resolve them. For this reason, an extremely high resolution experiment is being tried this summer in Boulder to look at 10 m to 100 m resolutions to resolve the small-scale flows. That is not an issue of continuity; it is an issue of the fundamental resolution of your sensor.

QUESTION:

What are you doing in terms of publishing temperature pressure profiles in the microburst environment?

RESPONSE:

We are very close to publishing that data in connection with surface measurements. Of 130 microbursts that have been identified and will be published through JAWS, we are going to characterize all of those parameters show the relationship to the gust front, to temperature,  $\Delta T$ 's,  $\Delta P$ 's, and velocity distributions for direct hit, near-miss, and distant microburst measurements.

## REFERENCES

1. JAWS Project Preliminary Data Description. National Center for Atmospheric Research, Boulder, Colorado, Sept. 1983.
2. Elmore, Kim: JAWS multiple Doppler derived winds. Wind Shear/Turbulence Inputs to Flight Simulation and Systems Certification, NASA CP-2474, 1987, pp. 29-42.
3. Fujita, Tetsuya Theodore: Andrews AFB microburst. SMRP research paper 205, Satellite and Mesometeorology Research Project, Dept. Geophys. Sci., Univ. Chicago, 1983.